Manufacturing Engineering Laboratory IT Testing Perspectives

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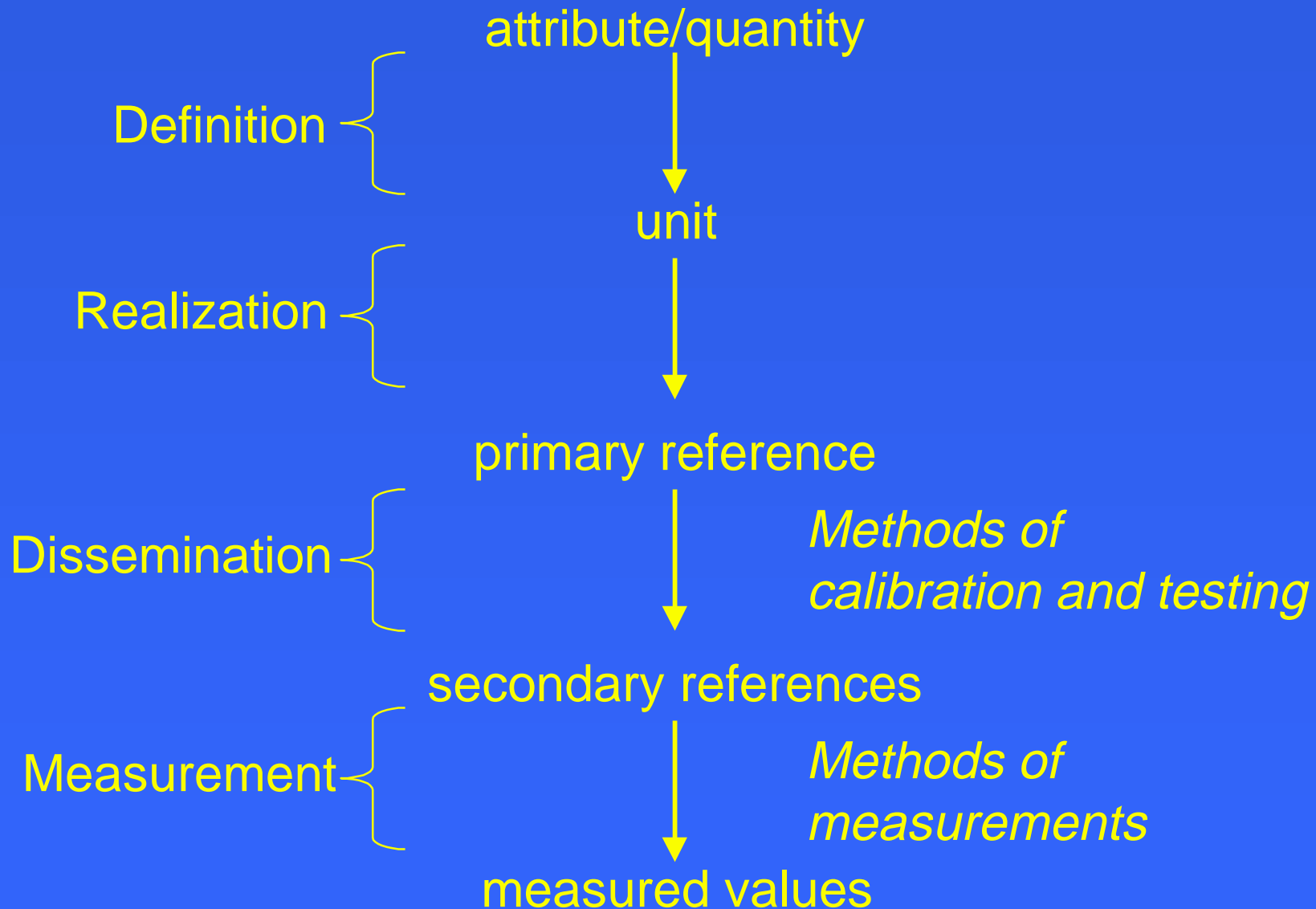
Outline

- IT Metrology

- Ongoing Testing Efforts

- New Testing R & D Efforts

- Potential IT Metrology Impacts

Metrology for Information Technology

- NIST Internal Report (6025) developed by ITL, MEL, TS
  - ✟ Concludes: IT Metrology Valid Branch of Metrology
  - ✟ Analogs to Physical Metrology....
    - — Validation -> Calibration
  - ✟ Differences from Physical Metrology....
    - —No recognized dimensioning system

Logical Relationships Among Metrology Concepts

attribute/quantity

Definition

↓

unit

Realization

↓

primary reference

Dissemination

↓   *Methods of calibration and testing*

secondary references

Measurement

↓   *Methods of measurements*

measured values

Opportunities for Advancing IT Metrology

- Level of confidence in test results
  - ✝ need to realize traceability & characterize uncertainty for IT testing

- Interoperability testing
  - ✝ need better testing methods & interpretation of results

- Automatic generation of test code
  - ✝ need to reduce costs of generating test code & improve test coverage

- Software metrics
  - ✝ need to identify what's appropriate to test

- Algorithm testing
  - ✝ need algorithm performance measures to enable intercomparisons

Ongoing Testing Efforts
in the
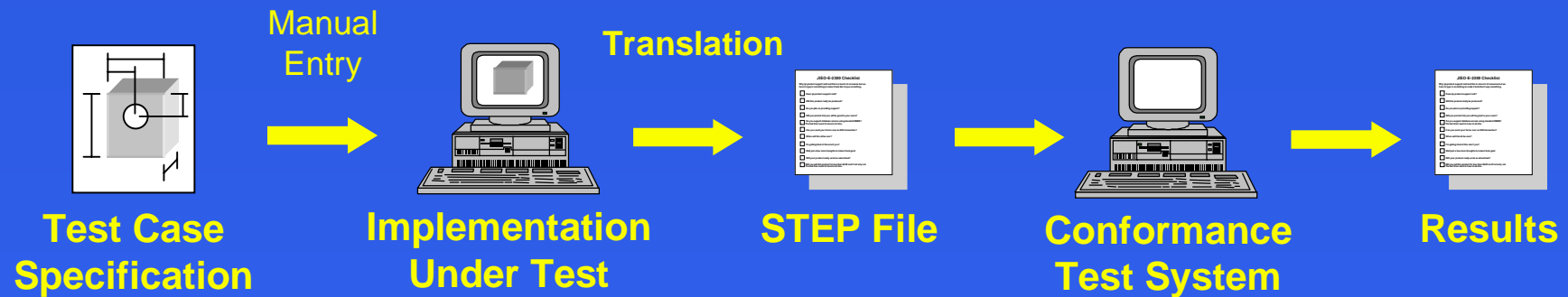# Manufacturing Engineering Laboratory

- STEP Testing

- Algorithm Testing & Evaluation Program

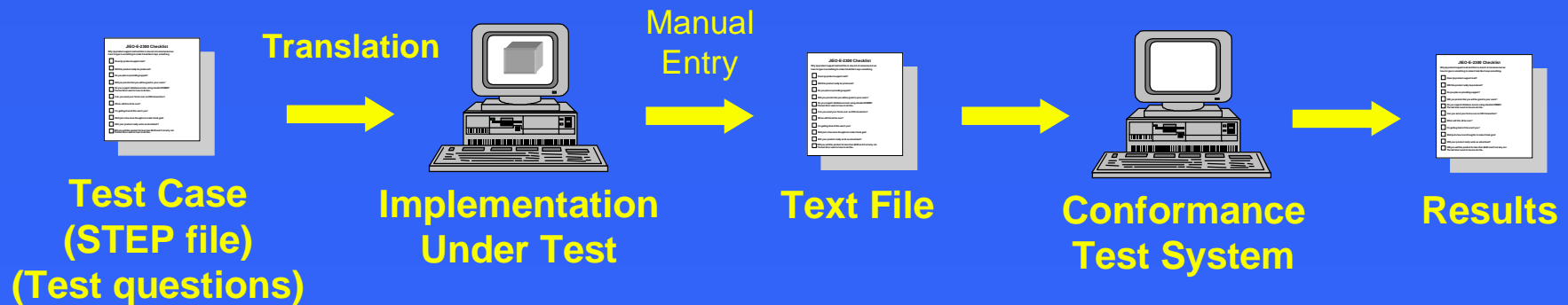- Infrastructure Evaluation

STEP Testing
POC: Simon Frechette

- Standard for the Exchange of Product model data (ISO 10303)

- STEP Application Protocols define what data is to be exchanged among what engineering systems, for what purposes, in what context
  - ✝ AP203 (ISO10303-203) Configuration Controlled 3D Design
  - ✝ AP214 (ISO 10303-214) Core Data for Automotive Design Processes
  - ✝ … (~ 12 more)

- Commercial implementations available from all major computer-aided design system vendors

- Abstract Test Suites are defined for each AP as part of the standard

STEP Conformance Testing

Test Case Specification → *Manual Entry* → **Implementation Under Test** → *Translation* → **STEP File** → **Conformance Test System** → **Results**

Pre-processor test (can you write a STEP file?)

Test Case (STEP file) (Test questions) → *Translation* → **Implementation Under Test** → *Manual Entry* → **Text File** → **Conformance Test System** → **Results**

Post-processor test (can you read a STEP file?)

STEP Conformance Testing: Web Site

Welcome to the NIST-ITI Test System (NITS)

Are you a registered user and want to do some work?
Please login --- Name: [   ]   Password: [   ]   <u>Let's Go!</u>
.

Update announcements ... click <u>here!</u> (last update - 7/8/97)

Just want to browse?
You can access many of the NITS resources as a public user without logging in. A good place to start is in the <u>public user's project</u>

Want to start using the NITS tools?
You'll be able to create, store, and retrieve your own private data But first you will need to <u>register as a NITS user</u>.

NITS provides a protocol testing environment, acting as a harness for test tools and data. To learn more about main concepts and features, see the <u>overview of NITS</u>.

NITS - bringing conformance testing to your desktop! Comments and questions -- send them here.
A public service of the <u>National Institute of Standards and Technology</u> and the <u>Industrial Technology Institute</u>

STEP Conformance Testing: Online Results

NITS

PROTOCOL TESTING

Test Case Data

TEST CASE RESULT: Done
Preprocessor test case: ab1g
Verdict: Fail

Test Case Specification: /ab1.html
Your submitted part 21 file: /gasket1.p21
Structure analysis: ... Done   ... FAIL
Semantic analysis: ... Done   ... PASS
_____

STEP Rule Evaluator v 1.8.9 for AP 203 (IS)
Reading data from /gasket.p21
ERROR: ENTITY #9043 Uncertainty_Measure_With_Unit
Missing attribute values
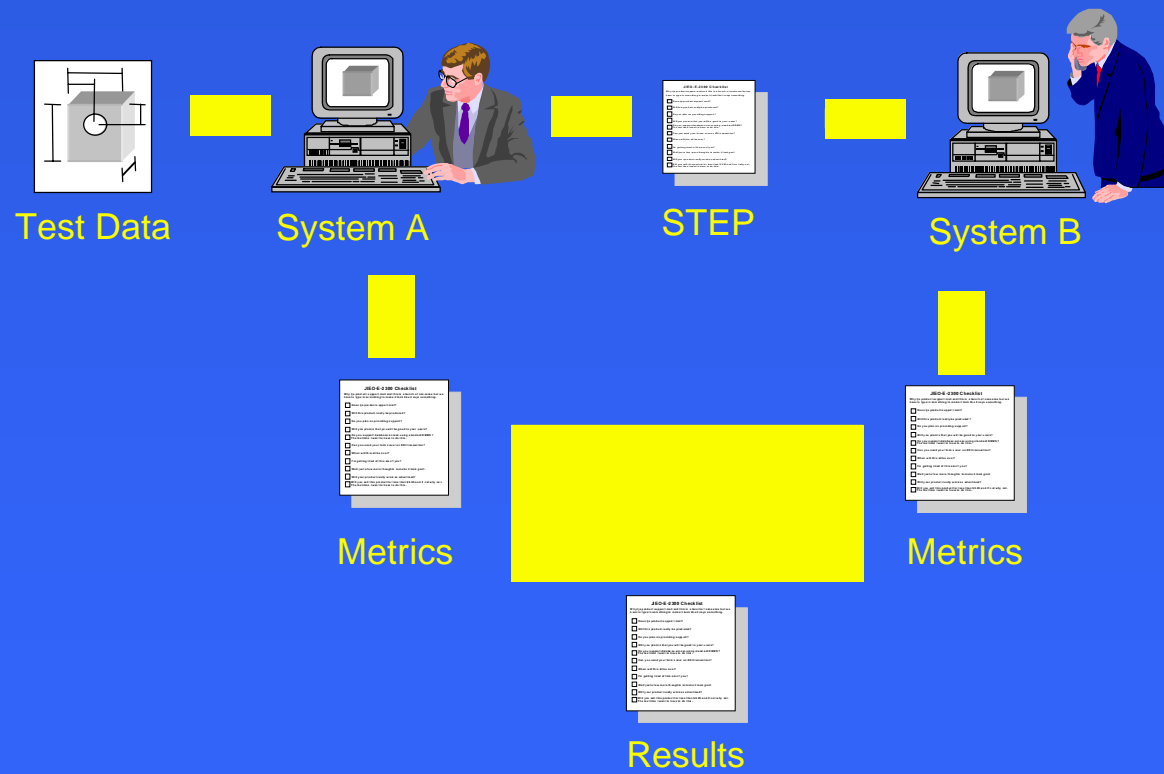ERROR in EXCHANGE FILE: incomplete instance #9043

total violations = 0
total parse errors = 1
total parse warnings = 0
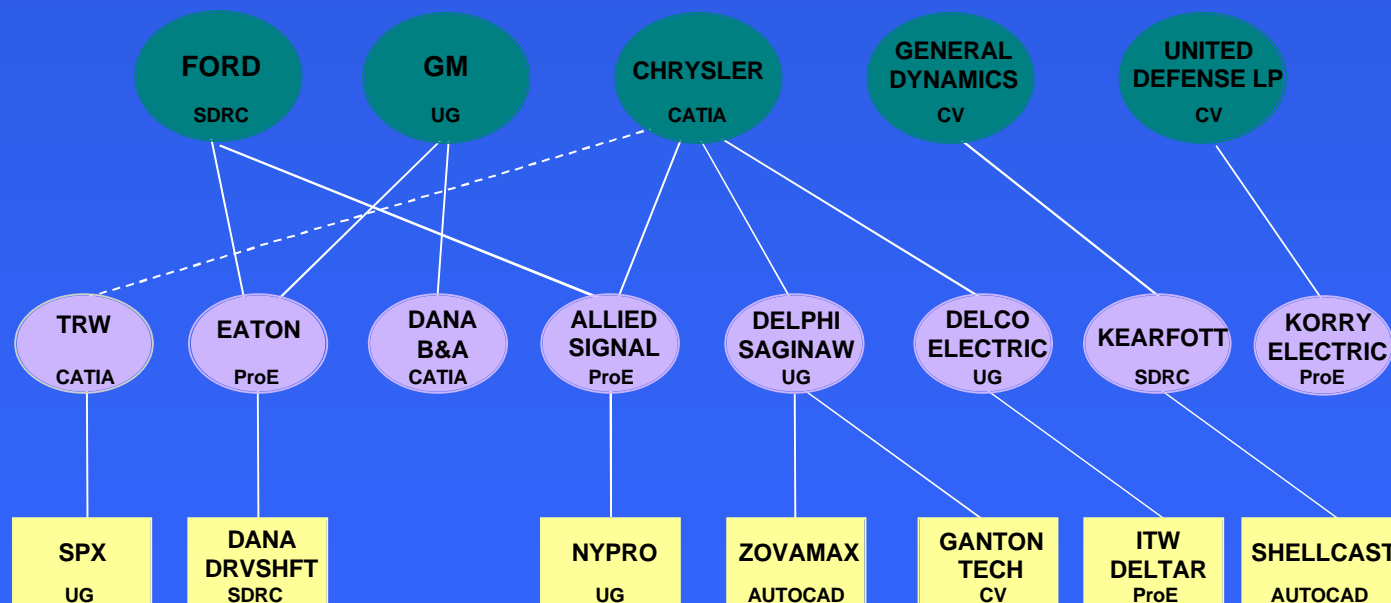elapsed time: 5.348 seconds

STEP Interoperability Testing

Interoperability Testing of STEP Applications

Test Data System A STEP System B

Metrics Metrics

Results

STEP Interoperability Testing: AutoSTEP

Interoperability Testing
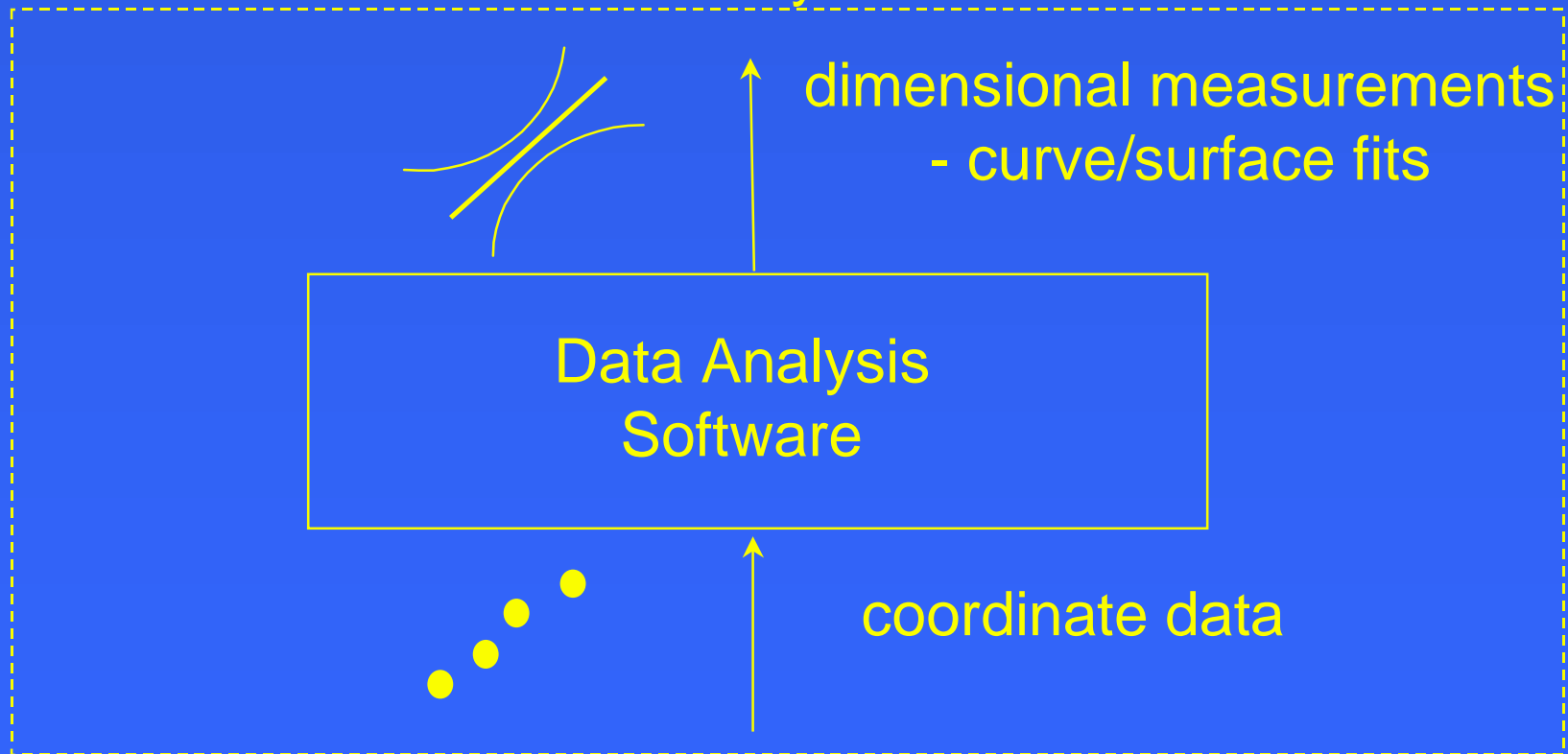### AIAG AutoSTEP Production Pilot Project

STEP Testing Summary

- Methods development

- Tool development

- Facilitating industry-led certification program

- $ saved by CAD vendors for early translator error detection

- Interoperable STEP implementations

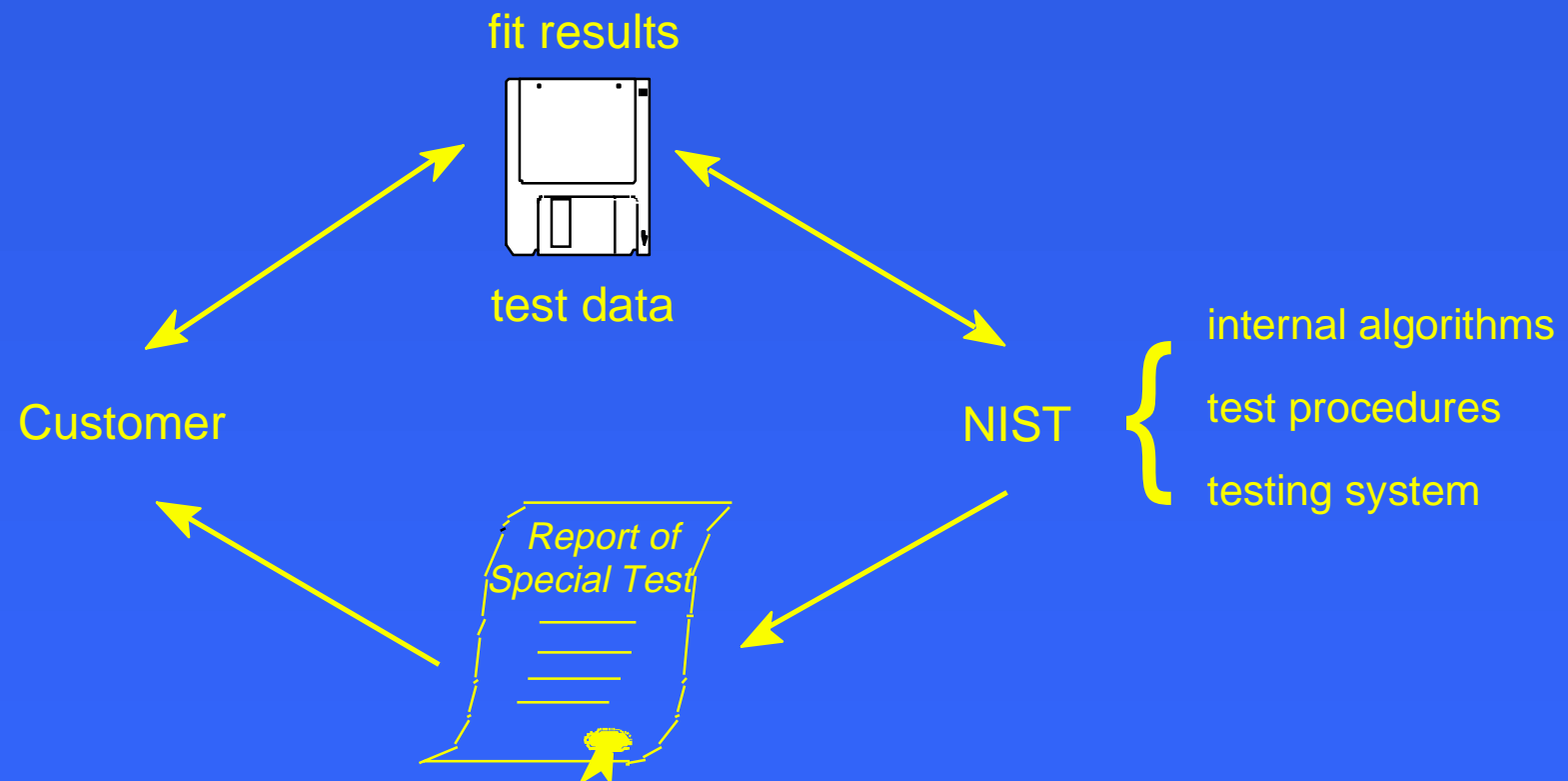- Production use of STEP

Algorithm Testing & Evaluation Program
POC: Craig Shakarji

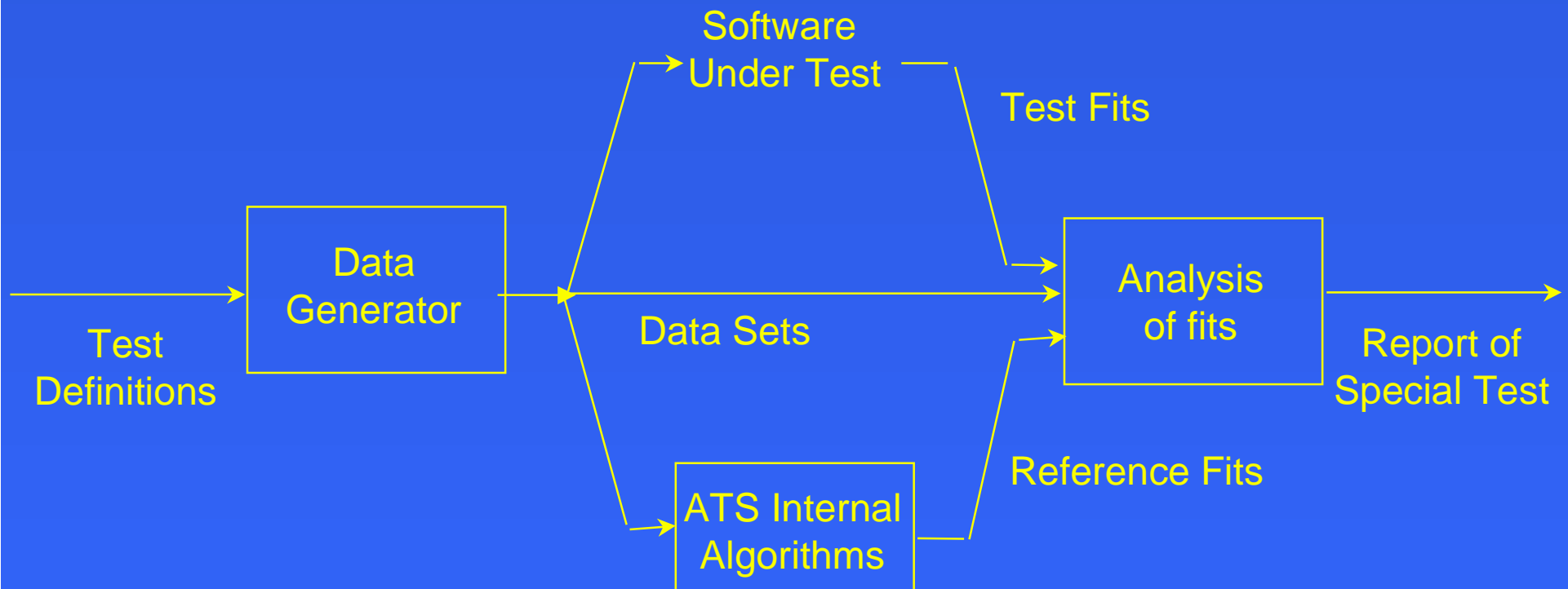**There is unknown measurement uncertainty associated with software embedded in coordinate measuring systems**

coordinate measurement system

dimensional measurements
- curve/surface fits

Data Analysis
Software

coordinate data

Algorithm Testing Program

fit results

test data

Customer

NIST

{ internal algorithms

test procedures

testing system

Report of Special Test

Algorithm Testing Architecture

Test
Definitions

Data
Generator

Software
Under Test

Test Fits

Data Sets

ATS Internal
Algorithms

Reference Fits

Analysis
of fits

Report of
Special Test

Algorithm Testing Summary

- First calibration service in the U.S. for dimensional metrology software

- ATEP-CMS available as Special Test Service

- Test objectives codified in standards

- Web resource soon available

Infrastructure Evaluation
POC: Neil Christopher

- Test implementations of manufacturing software architectures in real and/or simulated environments
    - ✟ SEMATECH CIM-Framework
    - ✟ Honeywell Advanced Process Control Framework

- Collaboration with CMU Software Engineering Institute to test CORBA for real-time performance

- Developed Manufacturer's CORBA Interface Testing Toolkit (MCITT) for testing of software interfaces based on CORBA

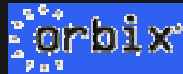# Infrastructure Evaluation: MCITT
POC: David Flater
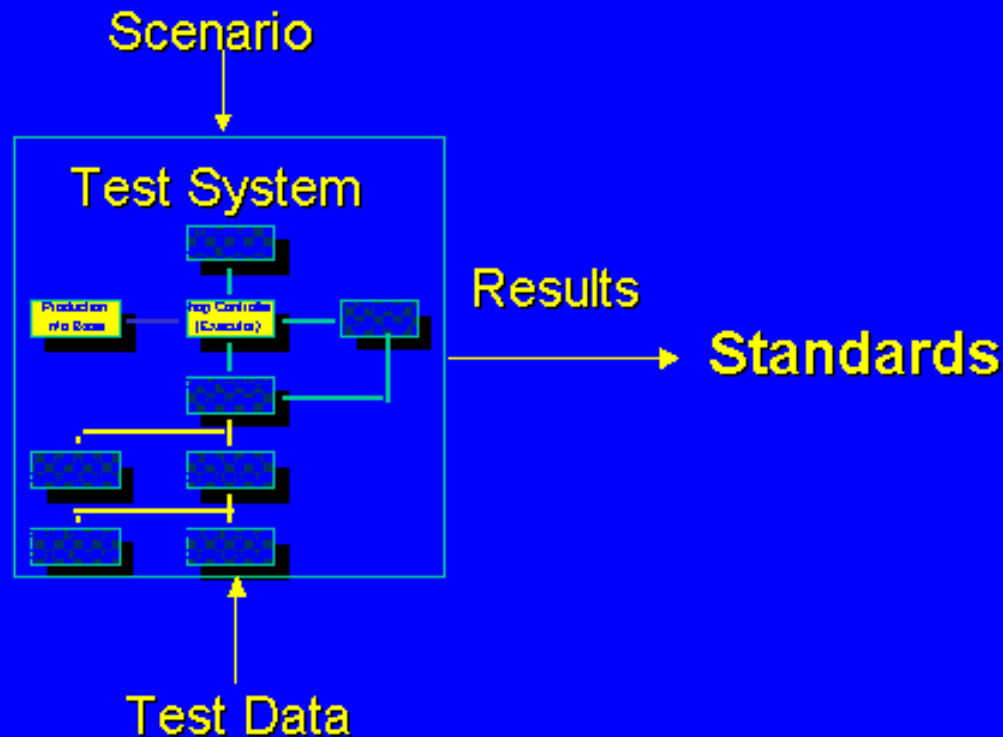
How can we test interfaces without implementing the entire system?

Infrastructure Evaluation: MCITT

Solution

Interface Definition

```
module PDMwrapper {
    ....... Lots of other interfaces ......
    interface DocumentForm {
        attribute Label documentFormat;
        .... Lots of other attributes ......
    }
}
```

orbix

Orbix-generated
interface code

Behavior Specification

```
declare PDMwrapper::ProductSpecificationManager PDM ......

begin PDMwrapper::DocumentForm::documentFormat
    return "Document Text"
end PDMwrapper::DocumentForm::documentFormat

begin main
    create PDM
    serve "PDM"
end main
```

MCITT

MCITT-generated
implementation code

CORBA Server

- Interface Testing Language
- Code generation

New Testing R&D Efforts

- Testability of Interaction-Driven Manufacturing Systems (Manufacturing Engineering Laboratory)

- Standards & Validation for Bioinformatics (Chemical Science & Technology Laboratory)

- Strategies for Testing Software-Embedded Systems (Electrical & Electronics Engineering Laboratory)

Testability of Interaction-Driven Manufacturing Systems
POC: David Flater/K.C. Morris

New System Characterization

"Large and complex distributed systems of systems" --
Genevieve Houston-Ludlam, Program Chair, 16th Int'l Conf. on
Testing Computer Software
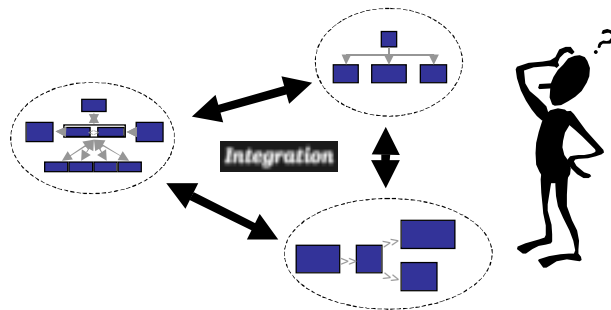
Yesterday's "systems" are today's "components"

- Goals:
  - ✞ find or develop tools and techniques:
    - —for specifying interaction-driven manufacturing systems
    - —for locating faults in ...
    - —for testing conformance of ...
    - —for designing systems with improved testability

- First Year Results
  - ✞ Characterized "the problem(s)"
  - ✞ Surveyed potential solution approaches
  - ✞ Identified the unsolved problems
  - ✞ Set future directions

Standards & Validation for Bioinformatics
POC: Gary Gilliland/Lynn Young
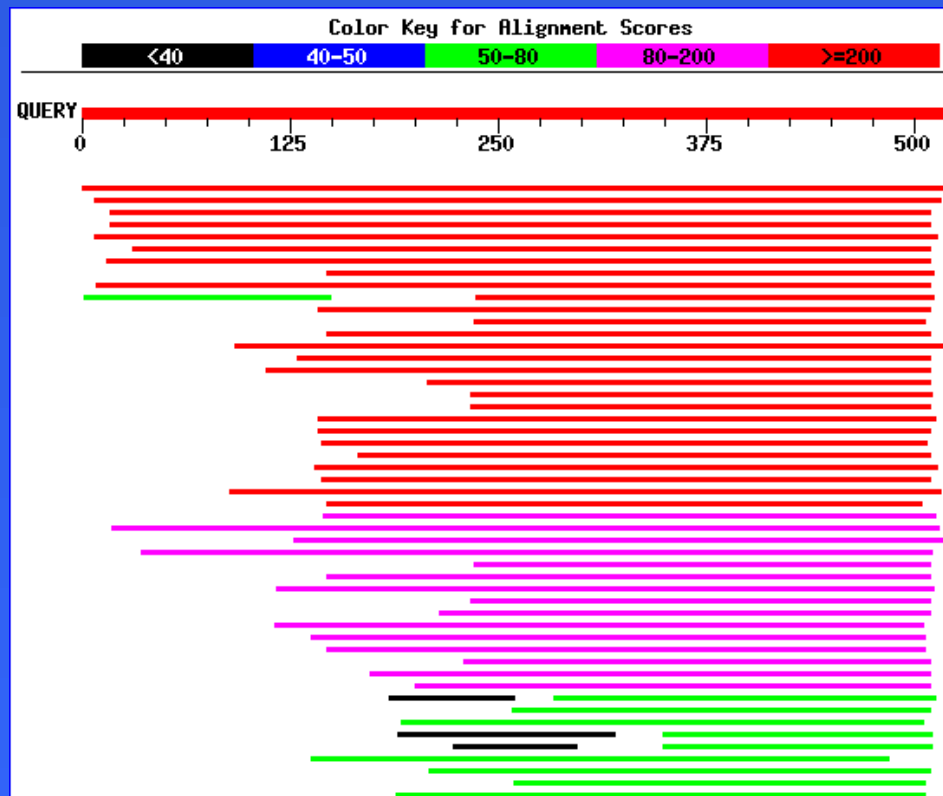
Basic Local Alignment Search Tool

- Goals:
  - ✝ Analyze bioinformatics algorithms
  - ✝ Analyze genome data
  - ✝ Develop software useful to the biology community
  - ✝ Acquire Protein Data Bank (PDB)

- First Year Results:
  - ✝ BLAST Formal Analysis
  - ✝ Sequence Structure Interface (Sesti)
  - ✝ Research Collaboratory for Structural Bioinformatics
  - ✝ Graphic visualization of DNA walks

Strategies for Testing Software-Embedded Systems
POC: Gerard Stenbakken/Michael Souders

SOFTWARE-EMBEDDED   SYSTEM

SOFTWARE

INPUT

ANALOG CIRCUIT

DIGITAL CIRCUIT

OUTPUT
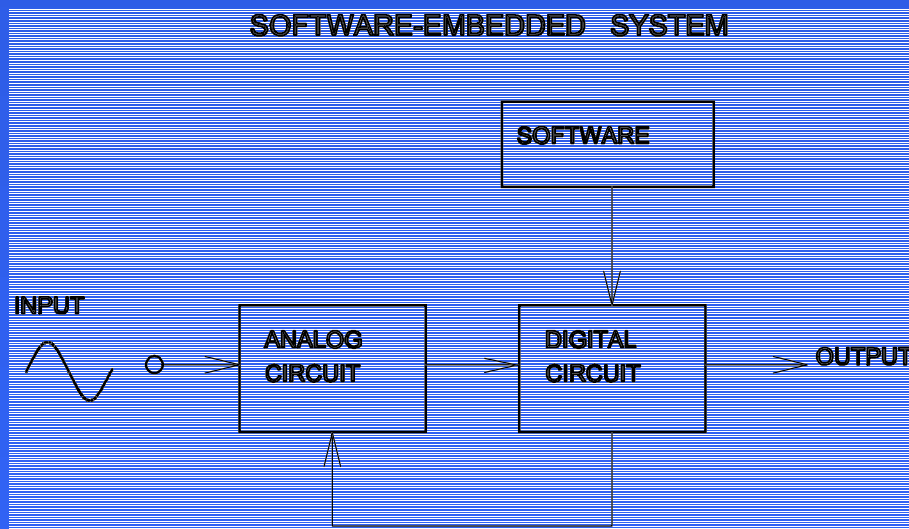
- Goals:
  - ✝ Develop Expertise in Testing Systems
  - ✝ Help Industry Delineate Problems
  - ✝ Improve Analysis Tools

- First Year Status:
  - ✝ Investigating Expectation Maximization Approach for:
    - —Updating Models with Missing Data
    - —Help in Searching Continuous Test Spaces
    - —Theoretical Basis for Minimum Amount of Information

Potential IT Metrology Impact Areas

	STEP Testing	ATEP	Infra. Eval	TIMS	SW Embedded Systems	Bioinformatics
Uncertainty/Traceability		X		X	X	
Conformance/Interoperability	X		X	X		
Automatic Test Generation		X	X	X	X	X
Software Metrics	X	X	X	X	X	X
Algorithm Testing		X			X	X